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BABCOCK ELECTRO-MECHANICAL INC.
3501 Harbor Blvd., Costa Mesa, CA 92626
Tel: (714) 540-1234

633 3744

Operation and Calibration Manual

Henn

BEMI -E298A-OCM

RELAY ADJUST TEST STATION

E298A
E298

CONTROLLED DOCUMENT

29 June 1976
4 October 1976
24 May 1978 REV

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L L Dake

L. Dake
Instrumentation Engineer

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1. SCOPE

This manual provides the user with operating and calibration instruction for the Relay Test Station, Model E298A.*

2. TEST EQUIPMENT

The following external test equipment, or equivalent, is required when calibrating the test set.

a. Fluke Digital Multimeter, Model 8000A

b. Fluke Multi-Counter, Model 1900A

c. Heath Decade Resistance, Model EU-30A

*Note: In this manual E298 is equivalent to E298A by deleting all reference to poles 5 and 6.

3. OPERATING PROCEDURE

a. Connect E298A-200 Control Unit to E298A-100A Relay Adjust Station. (J3 rear panel)

b. Connect appropriate relay test fixture to E298A-100. J1

c. Connect E298A-100 to 110-120 VAC, 60Hz, 1Ø.

d. Press AC LINE pushbutton to on.

e. Set Coil Voltage Adj knob fully counterclockwise.

f. Connect relay to be tested to relay test fixture.

g. Plug in Coil programming plug prepared as is figure 2 into Coil Program.

h. If Coil Voltage is AC or greater than 48 Vdc press Ext Coil button to on and go to step ae.

i. Press Pull-in/Latch pushbutton to on.

j. Press and hold Set Coil Vol pushbutton to on.

k. Turn Coil Voltage Adj knob until DVM reads required Coil Voltage. Release Set Coil Vol pushbutton.

l. Set in relay type into thumbwheel switches. (A relay with 3 poles, the first an "A", the second a "B", the third a "C", would be set; A-B-C-0-0-0.)

m. Press Latch pushbutton on if relay is a latching type.

n. Press-in lowest usable resistance range (2K or 20K) on Voltmeter Control so as to read coil resistance.

o. For relays with pull-in/drop-out (latch/reset) in Voltage, press-in DC-Volt on Voltmeter Control and go to Step q (ah).

p. For relays with pull-in/drop-out (latch/reset) in current press-in DC-Amp and press-in lowest usable current range (200 or 2000 ma) on Voltmeter Control.

q. Press Coil 1 Res pushbutton to on, read Coil 1 resistance on DVM.

r. Press Coil 2 Res pushbutton to on (If relay under test is two coil relay), read Coil 2 resistance on DVM.

s. Press Pull-in/Latch pushbutton to on. DVM reads pull-in/latch voltage/current after approximately 10 seconds.

t. Press Drop-out/Reset pushbutton to on. DVM reads drop-out/reset voltage/current after approximately 10 seconds.

u. Press Time pushbutton to on. Press Oper./Rel. and Pole 1 pushbuttons to on.

v. Press Test pushbutton to on and release. Operate counter reads operate bounce time, release counter reads release time.

w. Press Bounce/Time pushbutton to on.

x. Press Test pushbutton to on and release. Operate counter reads operate bounce time, release counter reads release bounce time.

y. Press Xfer/Time pushbutton to on.

z. Press Test pushbutton to on and release. Operate counter reads operate transfer time, release counter reads release transfer time.

aa. Repeat steps u through z for Poles 2,3,4,5 and 6, if required. Note that relay time can be verified with an oscilloscope by connecting the vert. amplifier to J14 (vert.) and the

trigger input to J15 (trig.) adjust oscilloscope to trigger on a negative going voltage.

ab. Press Contact Res pushbutton to on. Press Pole 1 pushbutton to on. Press Test NC pushbutton to on. DVM reads contact-resistance NC1. in ohms.

ac. Press Test NO pushbutton to on. DVM reads contact resistance NO1. in ohms.

ad. Repeat steps ab and ac for poles 2,3,4,5 and 6, if required.

ae. External Coil power procedure.

af. Connect variable voltage source to external jacks(J16, J17) on rear panel E298A-100 and set voltage source to 0 Volts.

ag. Repeat steps L through P.

ah. Press-in AC pushbutton on Voltmeter Control if an AC power source is used.

ai. Press Coil I Res. pushbutton to on, read Coil 1 resistance on DVM. Note: Valid readings may not be obtained with AC relays because of the bias voltage drop across diodes used in some relays.

aj. Press Coil 2 Res. pushbutton to on, read coil 2 resistance on DVM. See note in preceeding step.

ak. Press Pull-in/Latch pushbutton to on. increase source voltage until all normally-open contacts make. DVM reads pull-in/ latch voltage/current.

al. For non-latching type relay, increase source voltage to rated coil voltage. Press Drop-out/reset pushbutton to on and decrease source voltage.until all normally-closed contacts make, DVM reads drop-out voltage/current/

am. For latching type relay, decrease source voltage to 0 volts. Press Drop-out/Reset pushbutton to on and increase source

voltage until all normally-closed contacts make, DVM reads reset Voltage/current.

an. Press and hold Set Coil Vol pushbutton to on. Adjust source voltage until DVM reads rated coil voltage.

ao. Repeat steps u through aa.

ap. Repeat steps ab through ad.

4. CALIBRATION PROCEDURE

a. Connect line cord to 110-120 Vac, 60Hz, 1ø.

b. Connect E298A-200 Control unit to E298a-100 Relay Test Station.

c. Push off all pushbuttons on E298A-200 control unit.

d. Connect shorting plug between pin 2 and 10 J13 (DVM Plug)

e. Press AC Line pushbutton tc on. Allow 15 minutes to stabilize

f. Remove DVM snap-on bezel and adjust zero control (DVM-R31) for a reading of 0.

g. Remove shorting plug and connect voltage standard to 2 and 10 J18. Set voltage standard to 1.9000Vdc.

h. Adjust SPAN control for a reading of 19000 on DVM.

i. Remove voltage standard and install snap-on bezel.

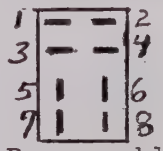
j. Adjust PS1 to 55±.5 Vdc.

k. Adjust PS2 to 15±.25 Vdc.

l. Adjust PS3 to 15±.25 Vdc.

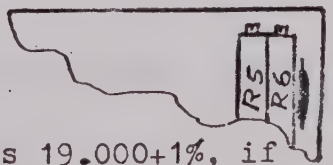
m. Adjust **R1 on the chassis terminal board for 6±.06 VDC at TP1.**

n. Connect standard resistance decade to coil programming connector (J3) pins 2 and 4.



o. Set resistance decade to 1900 ohms.

p. Set voltmeter control to 2K. Press Coil 1 Res pushbutton to on. DVM reads 1.9000±1%, if not, adjust R5, Card E2046 PC12.



q. Set resistance decade to 19.00K ohms.

r. Set voltmeter control to 20K. DVM reads 19.000±1%, if not, adjust R6, Card E2046 PC12.

s. Connect resistance decade to coil programming connector (J3) pin 1 and 3.

t. Press Coil 2 Res pushbutton to on. DVM reads 19.000±1%.

u. Connect frequency Counter to J1, Card E2023 PC3. Counter reads 100 KHz ±0.5%.

w. Connect standard voltmeter to coil programming connector (J3) pins 2 and 4.

x. Set voltmeter control to DC-Volts. Press Pull-in/Latch pushbutton to on. Press and hold Set Coil Vol pushbutton to on.

y. Adjust Coil Voltage to read 40.0 ±1%.

z. Connect standard amp meter (in series with a 100 ohm, 1 watt resistor) to coil programming connector (J3) pins 2 and 4.

aa. Set voltmeter control to DC-AMP-200 ma.

ab. Press Pull-in/Latch pushbutton to on. Press and hold Set Coil Vol pushbutton to on.

ac. Adjust coil voltage to read 100.0ma on standard amp meter. Digital panel meter reads 100.0 ±2%.

ad. Set Voltmeter Control + 2000ma. Digital panel meter reads 0.100 ±2%.

ae. Connect a variable A.C. voltage source to rear panel external coil jacks (J16, J17).

af. Connect standard AC voltmeter to coil programming connector (J3) pins 2 and 4.

ag. Press Exit Coil pushbutton to on. Set voltmeter control to AC Volts. Press Pull-in/Latch pushbutton to on.

ah. Adjust AC Voltage source to read 100 VRMS on standard AC voltmeter. Digital panel meter reads 100.0 $\pm$2%.

5. PARTS LIST

Pages 10 through 24 contains parts listing for the E298A test set.

6. SCHEMATICS

Schematics for the E298A are contained in the back of this manual.

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BABCOCK RELAYS

CODE IDENT	PL	REV	SHEET
56623	E298-100		1 OF 3

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	2		E2023	BABCOCK	FUNCTION TIME CARD	PC3,5	
2	1		E2024	BABCOCK	CONTROL CARD	PC8	
3	2		E2026	BABCOCK	DECODER/DISPLAY CARD	PC4,6	
4	1		E2028	BABCOCK	STAIRCASE GENERATOR CARD	PC9	
5	1		E2029A	BABCOCK	ATLO CARD	PC2	
6	1		E2046	BABCOCK	MULTIMETER CARD	PC11	
7	1		E2047	BABCOCK	RELAY CARD	PC10	
8	1		E2048	BABCOCK	CONTACT LOAD AND SELECT CARD	PC1,7	
9	1		8310A	BALLANTINE	DIGITAL PANEL METER	DPM1	
10	1		HB48-0.5	POWER ONE	POWER SUPPLY	PS1	
11	1		HC15-3.0	POWER ONE	POWER SUPPLY	PS2	
12	1		HA15-0.5	POWER ONE	POWER SUPPLY	PS3	
13	9		01-951 (G)	UNIMAX SWITCH	INDICATOR LENS, ENGRAVED, NC1,		
					NC2,NC3,NC4,NO1,NO2,NO3,NO4		
					Coil Vol.		
14	14		01-050	UNIMAX SWITCH	INDICATOR	DS11 THRU 22	
15	2		01-282	UNIMAX SWITCH	INDICATOR/SWITCH	S3,4,-DS3,4	
16	1		01-951 (O)	UNIMAX SWITCH	INDICATOR LENS, ENGRAVED AC LINE		
17	2		01-283	UNIMAX SWITCH	INDICATOR/SWITCH	S1,2-DS1,2	
18	2		01-951 (Y)	UNIMAX SWITCH	INDICATOR LENS, ENGRAVED EXT.COIL,		
					LATCH		

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
19	1		4B197601M-03	EECO	THUMBWHEEL SWITCH ASSY.	S9 THRU 14	
20	6		1N4148	T.I.	DIODE	CR1 THRU 6	
21	6		HP 5082-4655	HEWLETT-PACKARD	LIGHT EMITTING DIODE, RED	DS5 THRU 10	
22	1		DTS-411	DELCO	TRANSISTOR	Q1	
23	2		V150ZA1	GENERAL ELECTRIC	VARISTOR, 150 VRMS	VR1,2	
24	1		LM340T-5.0	NATIONAL	IC, VOLTAGE REGULATOR	Z1	
25	6		RCR07G75L1S	ALLEN-BRADLEY	RESISTOR, 750 OHMS, ¼ W	R4 THRU 9	
25A	2		E298-103	BABCOCK	LENS		
26	1		RCR07G511JS	ALLEN-BRADLEY	RESISTOR, 510 OHMS, ¼ W	R2	
27	1		RCR07G622JS	ALLEN-BRADLEY	RESISTOR, 6.2K OHMS, ¼ W	R3	
28	1		JA1N200P103AA	ALLEN-BRADLEY	RESISTOR, 10K OHMS, 2W, POT	R10	
29	1		43P101	SPECTROL	RESISTOR, 100 OHMS, TRIMPOT	R1	
30	1		P308-DB	CINCH	CONNECTOR, 8 PIN, MALE	J2	
31	1		2KU15D/1-2	VIKING	CONNECTOR, 30 PIN, FEMALE	J13	
32	7		00-7008-035-163-02	ELCO	CONNECTOR, 35 PIN, FEMALE	J5, 6, 7, 9, 10, 11, 12	
33	2		00-7008-047-163-02	ELCO	CONNECTOR, 47 PIN, FEMALE	J4, 8	
34	1		MRAC-505-J	CONTROL DATA	CONNECTOR, 50 PIN, FEMALE	J1, 3	
35	2		UG625 B/U	AMPHENOL	CONNECTOR, BNC	J14,15	
36	1		DF-30 BC	SUPERIOR ELECTRIC	CONNECTOR, 5-WAY BINDING POST, BLACK	J16	
37	1		DF-30 RC	SUPERIOR ELECTRIC	CONNECTOR, 5-WAY BINDING POST, RED	J17	

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BABCOCK RELAYS

CODE IDENT	PL	REV	SHEET
56623	E298-100		3 OF 3

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
38	48		RC16M-23	BURNDY	PIN, FEMALE FOR ITEM 33		
39	2		342038	LITTLEFUSE	FUSE HOLDER	F1,2	
40	1		WR2A1	ROTRON	FAN		
41	1		17405	BELDEN	AC LINE CORD		
42	1		550481	ROTRON	FAN GAURD		
43							
44	1		17252	BELDEN	AC LINE CORD RECEPTACLE		
45	1		10-140	CINCH	TERMINAL STRIP	TB1	
46	1		3976-205-5	ERIE	TERMINAL STRIP	TB2	
47	16		5530-12V, 50mA	TAUNUSLICHT	LAMPS, 12V, 50 mA		
48	1		E298-105	BABCOCK	CHASSIS		
49	1		E298-110	BABCOCK	FRONT PANEL		
50	1		E298-115	BABCOCK	REAR PANEL		
51	1		E298-130-1	BABCOCK	CHASSIS MTG. BRACKET		
52	1		SMS719B	SYSTEM METALS INC.	ENCLOSURE, COLOR #25189		
52A	1		E298-130-2	BABCOCK	CHASSIS MOUNTING BRACKET		

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CODE IDENT		REV	SHEET
56623	PL E298-200	NC	1 OF 1

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	1		6XCL17.5CSRBLK,	1EE/SCHADOW	INDICATOR/SWITCH, INTERLOCKED	S/DS 1 THRU 6	
			BLU,4U GR +SP				
2	1		4XCL17.5CSRBLK,	1EE/SCHADOW	INDICATOR/SWITCH, INTERLOCKED	S/DS11 THRU 16	
			RED,4UGR +SP				
3	1		4XCL17.5CSRBLK,	1EE/SCHADOW	INDICATOR/SWITCH, INTERLOCKED	S/DS 7 THRU 10	
			YELL,4UGR + SP *		* STATION #4 HAS GREEN LENS AND IS OA		
4	1		2XCL17.5CSRBLK	1EE/SCHADOW	INDICATOR/SWITCH, INTERLOCKED	S/DS 17,18	
			ORG,4UGR +SP				
5	19		1N4148	T.I.	DIODE	CR1 THRU 19	
6	16		5530-12V, 50 mA	TAUNUSLICHT	LAMP, 12V, 50mA		
7	1		MRAC-50P-JT	CONTROL DATA	CONNECTOR, 50 PINS, MALE	P1	
8	48		RM16M-23	BURNDY	CONNECTOR PINS FOR ITEM 7		
9	1			SYSTEMS METALS	BAIL FOR ITEM 10		
10	1		MICRO-MINI, H-5	SYSTEMS METALS	ENCLOSURE		
			1/4W-6 1/2, D-6 1/2				
11	1		E298-210	BABCOCK	FRONT PANEL		

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PARTS LIST

E2023

REV	DATE	SHEET
B	6-19-74	1 OF 2

ITEM NO.	QTY REQ'D	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL
1	2	RCR07G202JS	Allen-Bradley	Resistor, 1/4W, 2K Ohms	R 1, 5
2	1	RCR07G503JS	Allen-Bradley	Resistor, 1/4W, 50K Ohms	R 4
3	2	RCR07G104JS	Allen-Bradley	Resistor, 1/4W, 100K Ohms	R 2, 3
4	1	831-000C0G0100D	Erie	Capacitor, 10pf., 500V	C 5
5	1	5020EQ100RD103M	Emcap	Capacitor, .01uf, 100V	C 1,3,7
6	1	5030ES100RD104M	Emcap	Capacitor, .1uf, 100V	C 4
7	1	5040ES100RD105M	Emcap	Capacitor, 1.0uf, 50V	C 6
8	1	500D106G025BB7	Sprague	Capacitor, 10uf, 25V	C 2
9	8	IN4148	T.I.	Diode	CR 1 Thru 8
10	2	HiNil 321AJ	Teledyne	Two-Input NAND Gate	U 1, 4
11	2	HiNil 312AJ	Teledyne	Flip-Flop	U 2, 3
12	4	HiNil 370AJ	Teledyne	Quad D Flip-Flop	U 10, 11, 12, 13
13	4	HiNil 371AJ	Teledyne	Decade Counter	U 6, 7, 8, 9
14	1	LM311N	National	Voltage Comparator	U 5
15	1	Z-6A-100K HZ	Peterson Radio	Crystal, ±.005%	Xtal-1
16	3	10A1N-AA12	Babcock	Relay, Reed, 1FA, 12V	K 1, 2, 3
17	1	10A1N-AB12	Babcock	Relay, Reed, 1FC, 12V	K 4

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PARTS LIST E2023

REV	DATE	SHEET
B	6-19-74	2 OF 2

ITEM NO.	QTY REQ'D	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL
18	1	C840802	T.I.	8 Pin Dip Socket	XU 5
19	12	C841602	T.I.	16 Pin Dip Socket	XU 1, Thru 4, 6 Thru 13
20	1	00-7021-035-000-001	Elco	35 Pin Connector Plug	J 2
21	1	E2023	Babcock	Printed Circuit Card	E2023
22	1	TJ-208W	Raytheon	Test Jack	J 1

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CODE IDENT		REV	SHEET
56623	PL E2024A		1 OF 1

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	3		HINIL321AJ	TELEDYNE	I.C., QUAD 2-INPUT NAND GATE	U5,12,13	
2							
3	5		NE555V	SIGNETICS	I.C., TIMER	U6,8,9,11,14	
4	2		HINIL313AJ	TELEDYNE	I.C., DUAL J-K MASTER/SLAVE FLIP-FLOP	U7,10	
5	2		2N6426	MOTOROLA	TRANSISTOR	Q1,2	
6	8		1N4148	T.I.	DIODE	CR1 THRU CR8	
7			UK50-103	CENTRALAB	CAPACITOR, .01 uf, 25V	C1,2,4,5,6,7,9,10, 14,15,17,18,19	
8	5		CR30D105M	CENTRALAB	CAPACITOR, 1.0 uf, 25V	C3,8,11,12,16	
9	1		500D106G25BB7	SPRAGUE	CAPACITOR, 10 uf, 25V	C13	
10							
11	6		RCR07G202JS	ALLEN-BRADLEY	RESISTOR, 2K OHMS, 1/4W	R6,8,10,12,15,18	
12	2		RCR07G242JS	ALLEN-BRADLEY	RESISTOR, 2.4K OHMS 1/4W	R1,2	
13							
14	2		RCR07G203JS	ALLEN-BRADLEY	RESISTOR, 20K OHMS, 1/4W	R14,16	
15	3		RCR07G514JS	ALLEN-BRADLEY	RESISTOR, 510K OHMS, 1/4W	R7,11,17	
16	2		RCR07G105JS	ALLEN-BRADLEY	RESISTOR, 1 MEGOHM , 1/4W	R9,13	
17	1		15A1N-AA12	BABCOCK	RELAY, REED, 1 FA, 12V	K1	
18	1		15A1N-AB12	BABCOCK	RELAY, REED, 1 FC, 12V	K2	
19	5		C841602	T.I.	CONNECTOR, 16 PIN DIP		
20	5		C840802	T.I.	CONNECTOR, 8 PIN DIP		
21	1		00-7021-035-00-001	ELCO	CONNECTOR, 35 PIN, PC MOUNTING	P1	
22	1		E2024D-1	BABCOCK	PRINTED CIRCUIT CARD	E2024	

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CODE IDENT		REV	SHEET
56623	PL E2026	NC	1 OF 1

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	28		RCR07G511JS	ALLEN-BRADLEY	RESISTOR, 1/4W, 510 OHMS	R1 THRU 28	
2	1		RCR07G621JS	ALLEN-BRADLEY	RESISTOR, 1/4W, 620 OHMS	R29,30,31 or 32	
3	1		5020EQ100RD103M	EMCAP	CAPACITOR, .01uf, 100V	C2	
4	1		500D106G025BB7	SPRAGUE	CAPACITOR, 10uf, 25V	C1	
5	4		H1N11 383AJ	TELEDYNE	BCD TO SEVEN SEGMENT DECODER	U1,2,3,4	
6	4		3015F-BM15	READOUTS INC.	SEVEN SEGMENT DISPLAY	DS1,2,3,4	
7	8		C841602	T.I.	16 PIN DIP SOCKET	XU1 THRU 4,XDS1 -4	
8	1		E2026	BABCOCK	PRINTED CIRCUIT CARD	E2026	

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CODE IDENT		REV	SHEET
56623	PL E2028B	B	1 OF 2

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	1		RCR07G161JS	ALLEN-BRADLEY	160 OHMS, 1/4W, RESISTOR	R4	
2	1		RCR07G302JS	ALLEN-BRADLEY	3.0K OHMS, 1/4W, RESISTOR	R7	
3	1		RCR07G392JS	ALLEN-BRADLEY	3.9K OHMS, 1/4W, RESISTOR	R6	
4	8		RCR07G622JS	ALLEN-BRADLEY	6.2K OHMS, 1/4W, RESISTOR	R1,2,3,5,11,13,14,15	
5	1		RCR07G103JS	ALLEN-BRADLEY	10K OHMS, 1/4W, RESISTOR	R8	
6	1		RCR07G303JS	ALLEN-BRADLEY	30K OHMS, 1/4W, RESISTOR	R12	
7	1		RCR07G102JS	ALLEN-BRADLEY	1K OHMS, 1/4W, RESISTOR	R9	
8	1		RCR07G103JS	ALLEN-BRADLEY	10K OHMS, 1/4W, RESISTOR	R16	
9	1		RCR42G163JS	ALLEN-BRADLEY	16K OHMS 2W, RESISTOR	R17	
10	1		TYPE 43P203	SPECTROL	20K OHMS, TRIMPOT	R17	
11							
12	1		5010EQ100RD102M	EMCAP	.001uf, 100V, CAPACITOR	C7	
13	4		5020EQ100RD153M	EMCAP	.01uf, 100V, CAPACITOR	C2,4,6,10	
14	3		5040ES100RD105M	EMCAP	1.0uf, 50V, CAPACITOR	C3,5,8	
15	1		500D106G025BB7	SPRAGUE	10uf, 25V, CAPACITOR	C1	
16	1		M39006/09-1698	SPRAGUE	22uf, 25V, CAPACITOR	C9	
17	1		X663P	TRW	.01uf, 300V, CAPACITOR	C11	
18	2		2N4355	MOTOROLA	TRANSISTOR	Q1,2	
19							
20	1		1N5240	MOTOROLA	ZENER DIODE	CR1	
21	3		IN4148	T.I.	DIODE	CR2,3,4,5,6	

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CODE IDENT	PL	REV	SHEET
56623	E2028B	B	2 OF 2

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
22							
23	3		MM74C193	NATIONAL	UP/DOWN BINARY COUNTER	U1,2,3	
24	1		AD7520LN	ANALOG DEVICES	TEN BIT D.A.C.	U4	
25	1		3460	BURR BROWN	HIGH VOLTAGE OPERATIONAL AMPLIFIER	U6	
26							
27							
28	2		NE555V	SIGNETICS	TIMER	U7,8	
29	1		MM74C00	NATIONAL	TWO-INPUT NAND GATE	U9	
30	1		CA3747CE	RCA	OPERATIONAL AMPLIFIER	U5	
31	2		C840802	T.I.	8 PIN DIP SOCKET	XU7,8	
32	2		C841402	T.I.	14 PIN DIP SOCKET	XU5,9	
33	4		C841602	T.I.	16 PIN DIP SOCKET	XU1,2,3,4	
34							
35							
36	1		00-7021-035-00-001	ELCO	35 PIN CONNECTOR PLUG	J1	
37							
38	1		E2028A-1	BABCOCK	PRINTED CIRCUIT CARD	E2028A	

BABCOCK electro-mechanical, inc.
3501 Harbor Blvd., Costa Mesa, California 92626
BABCOCK RELAYS

CODE IDENT	PL	REV	SHEET
56623	E2029	C	1 OF 2

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	1		H1N11313AJ	TELEDYNE	I.C., DUAL J-K MASTER/SLAVE FLIP-FLOP	U1	
2	1		NE555V	SIGNETICS	I.C., TIMER	U2	
3	1		H1N11371AJ	TELEDYNE	I.C., DECADE COUNTER	U3	
4	1		H1N11380AJ	TELEDYNE	I.C., BCD TO DECADE DECODER	U4	
5	1		H1N11323AJ	TELEDYNE	I.C., QUAD 2-INPUT NAND GATE (O.C.)	U5	
6	2		H1N11321AJ	TELEDYNE	I.C., QUAD 2-INPUT NAND GATE	U6,7	
7	18		1N4148	T.I.	DIODE	CR1 -- CR18	
8	4		2N3440	MOTOROLA	TRANSISTOR	Q3,4,5,6	
9	2		2N6426	MOTOROLA	TRANSISTOR	Q1,2	
10	1		V33ZA1	G.E.	VARISTER, 33 VRMS	VR1	
11	4		10B1N-AC12	BABCOCK	RELAY, REED, 2 FA, 12V	K1,2,3,4	
12	3		UK50-103	CENTRALAB	CAPACITOR, .01 uf, 25V	C1,4,6	
13	1		CR20D104M2	CENTRALAB	CAPACITOR, .1 uf, 25V	C5	
14	1		CR30D105M	CENTRALAB	CAPACITOR, 1.0 uf, 25V	C3	
15	1		500D106G25BB7	SPRAGUE	CAPACITOR, 10 uf, 25V	2	
16	1		RCR07G101JS	ALLEN-BRADLEY	RESISTOR, 100 OHMS, 1/4 W	R17	
17	1		RCR07G201JS	ALLEN-BRADLEY	RESISTOR, 200 OHMS, 1/4 W	R18	
18	2		RCR07G202JS	ALLEN-BRADLEY	RESISTOR, 2.0K OHMS, 1/4 W	R19,20	
19	17		RCR07G622JS	ALLEN-BRADLEY	RESISTOR, 6.2K OHMS, 1/4 W	R1,4 -- R14,21,22,23,24,25	
20	1		RCR07G912JS	ALLEN-BRADLEY	RESISTOR, 9.1K OHMS, 1/4 W	R2	
21	3		RCR07G203JS	ALLEN-BRADLEY	RESISTOR, 20K OHMS, 1/4 W	R3,15,16	

BABCOCK electro-mechanical, inc.
3501 Harbor Blvd., Costa Mesa, California 92626
BABCOCK RELAYS

CODE IDENT		REV	SHEET
56623	PL E2029	C	2 OF 2

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
22	1		C840802	T.I.	CONNECTOR, 8 PIN, DIP	XU2	
23	6		C841602	T.I.	CONNECTOR, 16 PIN, DIP	XU1,3,4,5,6,7	
24	1		00-7021-035-00-001	ELCO	CONNECTOR, 35 PIN, P.C. MOUNTING	P1	
25	1		E2029C	BABCOCK	PRINTED CIRCUIT CARD	E2029	

BABCOCK electro-mechanical, inc.
3501 Harbor Blvd., Costa Mesa, California 92626
BABCOCK RELAYS

CODE IDENT	PL	REV	SHEET
56623	E2046	B	1 OF 2

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	1		LM308N	NATIONAL	I.C., OPERATIONAL AMPLIFIER	U1	
2	1		NE555V	SIGNETICS	I.C., TIMER	U2	
3	4		HiNi1302AL	TELEDYNE	I.C., QUAD 2-INPUT POWER GATE (O.C.)	U3,4,5,6	
4	1		MPF-161	MOTOROLA	TRANSISTOR	Q1	
5	17		1N4148	T.I.	DIODE	CR1 -- CR17	
6	8		10A1N-AA12	BABCOCK	RELAY, REED, 1FA, 12V	K1,2,3,5,6,7,8,10	
7	1		10B1N-AC12	BABCOCK	RELAY, REED, 2FA, 12V	K4	
8	1		10B1N-AB12	BABCOCK	RELAY, REED, 1FC, 12V	K9	
9	1		V33ZA1	G.E.	VARSISTOR, 33 VRMS	VR1	
10	1		500D505G025BA7	SPRAGUE	CAPACITOR, 5 uf, 25V	C1	
11	2		UK50-103	CENTRALAB	CAPACITOR, .01 uf, 25V	C2,6	
12	1		5GA-D10	SPRAGUE	CAPACITOR, .001 uf, 500V	C3	
13	1		CR30D105	CENTRALAB	CAPACITOR, 1.0 uf, 25V	C4	
14	1		500D256G025CB7	SPRAGUE	CAPACITOR, 25 uf, 25V	C5	
15	1		5GA-Q10	SPRAGUE	CAPACITOR, 10 pf, 500V	C7	
16	1		500D106G025BB7	SPRAGUE	CAPACITOR, 10 uf, 25V	C8	
17	1		RN55C2003F	CORNING	RESISTOR, 198K OHMS, .1% SELECTED FILM	R1	
18	1		RN55C2001F	CORNING	RESISTOR, 2.0K OHMS, .1% SELECTED FILM	R2	
19	1		RCR07G303JS	ALLEN-BRADLEY	RESISTOR, 30K OHMS, 1/4 W	R3	
20	1		RN55C33R2F	CORNING	RESISTOR, 33.2 OHMS, 1% FILM	R4	

BABCOCK electro-mechanical, inc.
3501 Harbor Blvd., Costa Mesa, California 92626
BABCOCK RELAYS

CODE IDENT	PL	REV	SHEET
56623	E2046	B	2 OF 2

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
21	1		43P503	SPECTROL	RESISTOR, 50K OHMS, TRIMPOT	R6	
22	1		RS-2C-1 Ohm, 1%	DALE	RESISTOR, 1 OHM, 1%, 3 WATT	R7	
23	1		RS-1B-9 Ohm, 1%	DALE	RESISTOR, 9 OHMS, 1%, 1 WATT	R8	
24	1		RN55C3012F	CORNING	RESISTOR, 30.1K OHMS, 1% FILM	R9	
25	1		RN55C1332F	CORNING	RESISTOR, 13.3K OHMS, 1% FILM	R10	
26	1		43P501	SPECTROL	RESISTOR, 500 OHM, TRIMPOT	R5	
27	1		43P104	SPECTROL	RESISTOR, 5K OHMS, TRIMPOT	R11	
28	1		RN55C5111F	CORNING	RESISTOR, 5.11K OHMS, 1% FILM	R12	
29	9		RCR07G622JS	ALLEN-BRADLEY	RESISTOR, 6.2K OHMS, 1/4 W	R13 - R30	
30	1		RCR07G511JS	ALLEN-BRADLEY	RESISTOR 510 OHMS 1/4 W	R31	
31	1		RCR07G395JS	ALLEN-BRADLEY	RESISTOR 4 MEGOHMS 1/4 W	R32	
32	1		102068	LITTELFUSE	FUSE HOLDER	XF1	
33	1		312002	LITTELFUSE	FUSE, 2 AMP, 3AG	F1	
34	2		C840802	T.I.	CONNECTOR, 8 PIN, DIP	XU1,2	
35	4		C841602	T.I.	CONNECTOR, 16 PIN, DIP	XU3,4,5,6	
36							
37	1		00-7021-035-00-001	ELCO	CONNECTOR, 35 PIN, P.C. MOUNTING	P1	
38	1		E2046A -1	BABCOCK	PRINTED CIRCUIT CARD	E2046	

BABCOCK electro-mechanical, inc.
3501 Harbor Blvd., Costa Mesa, California 92628
BABCOCK RELAYS

CODE IDENT	PL	REV	SHEET
56623	E2047	A	1 OF 1

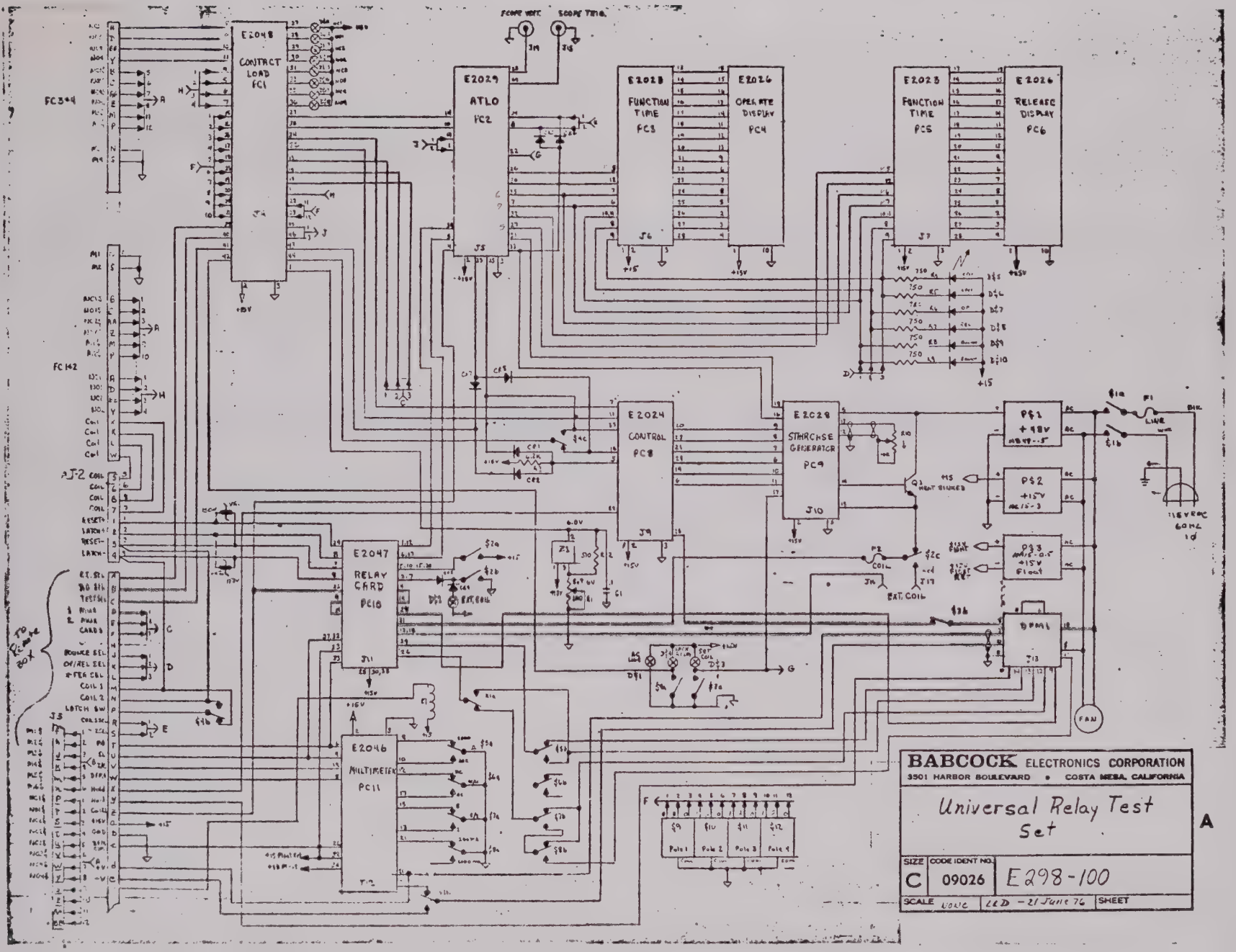
ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	7		HGSM5010	C.P. CLARE & CO..	RELAY, MERCURY-WETTED REED	K1 THRU 7	
2	1		00-7021-035-00-001	ELCO	35 PIN CONNECTOR PLUG	J1	
3	1		E2047	BABCOCK	PRINTED CIRCUIT CARD	E2047	
4	8		1N4148	T.I.	DIODE	CR1 THRU 8	

440027-1

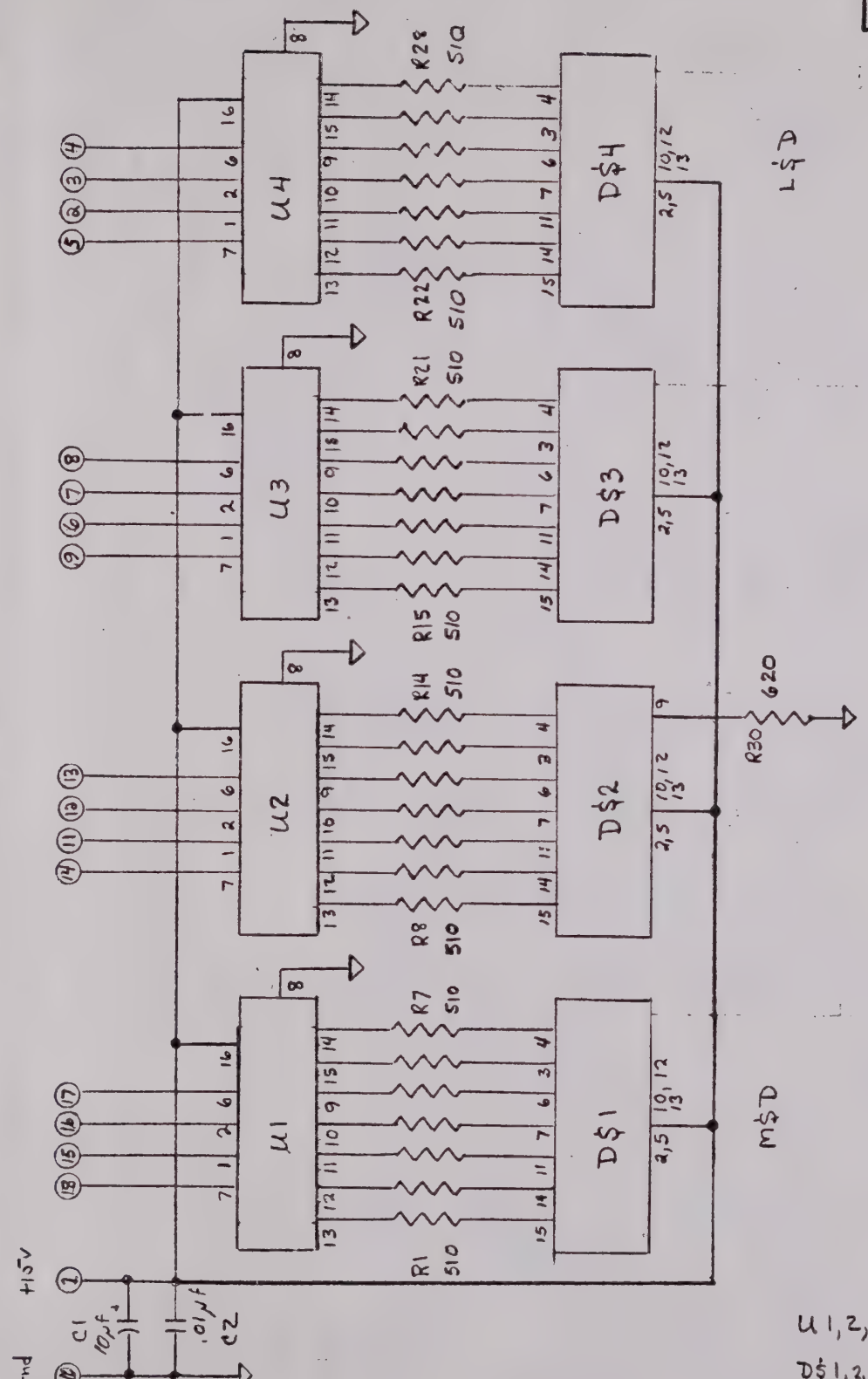
BABCOCK electro-mechanical, inc.
3501 Harbor Blvd., Costa Mesa, California 92626
BABCOCK RELAYS

CODE IDENT	PL	REV	SHEET
56623	E2048		1 OF 1

ITEM NO.	QTY REQD	CODE IDENT NO.	PART NO. OR IDENTIFYING NO.	MANUFACTURER	NOMENCLATURE OR DESCRIPTION	CIRCUIT SYMBOL	CLASS CODE
1	1		E2048-1	BABCOCK	PWB		
2							
3	2		LM339N	NATIONAL	I.C. QUAD COMPARITOR	U1,2	
4	2		HiNi1303AL	TELEDYNE	I.C. QUAD TWO INPUT POWER GATE	U3,4	
5	3		CD4053AE	RCA	I.C. TRIPLE 2-CHANNEL MULTIPLEXER	U5,6,7	
6	1		HiNi1351AJ	TELEDYNE	I.C. DUAL FOUR BIT MULTIPLEXER	U8	
7	3		HiNiL323AJ	TELEDYNE	I.C. QUAD 2 INPUT NAND GATE	U9,10,11	
8	2		MM74C04	NATIONAL	I.C. HEX INVERTER	U13,14	
9	1		HiNi1367AJ	TELEDYNE	I.C. QUAD SCHMITT TRIGGER	U12	
10							
11	1		500D505G025BA7	SPRAGUE	CAPACITOR, 5 uf, 25V	C1	
12	1		UK50-103	CENTRALAB	CAPACITOR, .01 uf	C2	
13	1		V33ZA1	G.E.	VARISTOR, 33 VRMS	VR1	
14							
15	8		RCR20G330JS		RESISTOR, 33 1/2 W, 5%	R29,31,33-38	
16	8		RS1B-60 Ohm, 1%	DALE	RESISTOR, 60 Ohm 1 W, 1%	R1 - 8	
17	2		RCR07G242JS		RESISTOR, 2.4K, 1/4 W, 5%	R30,32	
18	27		RCR07G512JS		RESISTOR, 5.1K, 1/4 W, 5%	R11-28,39-47	
19	2		RN55D1002F		RESISTOR, 10K, 1/10 W, 1%	R9,10	
20	1		00-7021-047-00-001	ELCO	CONNECTOR, 47 PIN, PC MOUNT MALE	P1	
21	10		C841602	T.I.	CONNECTOR, 16 PIN, DIP	XU3 - 12	
22	4		C841402	T.I.	CONNECTOR, 14 PIN, DIP	XU1,2,13,14	


E2048
CONTRACT LOAD FC1
E2029
ATLO
PC2
E2028
FUNCTION TIME
PC3
E2026
OPERATE DISPLAY
PC4
E2028
FUNCTION TIME
PC5
E2026
RELEASE DISPLAY
PC6
E2024
CONTROL
PC8
E2028
STHRCHSE GENERATOR
PC9
E2047
RELAY CARD
PC10
E2046
MULTIMETER
PC11
PS1
+48V
PS2
+15V
PS3
+15V
FC344
FC142
AJ-2
FAN
BABCOCK ELECTRONICS CORPORATION
3501 HARBOR BOULEVARD • COSTA MESA, CALIFORNIA
Universal Relay Test Set
A
SIZE C
CODE IDENT NO. 09026
E298-100
SCALE NONE
LED - 21 June 76
SHEET

DRAWING NUMBER
E2026



U1,2,3,4 – HiNil 383AJ (16 PIN DIP)

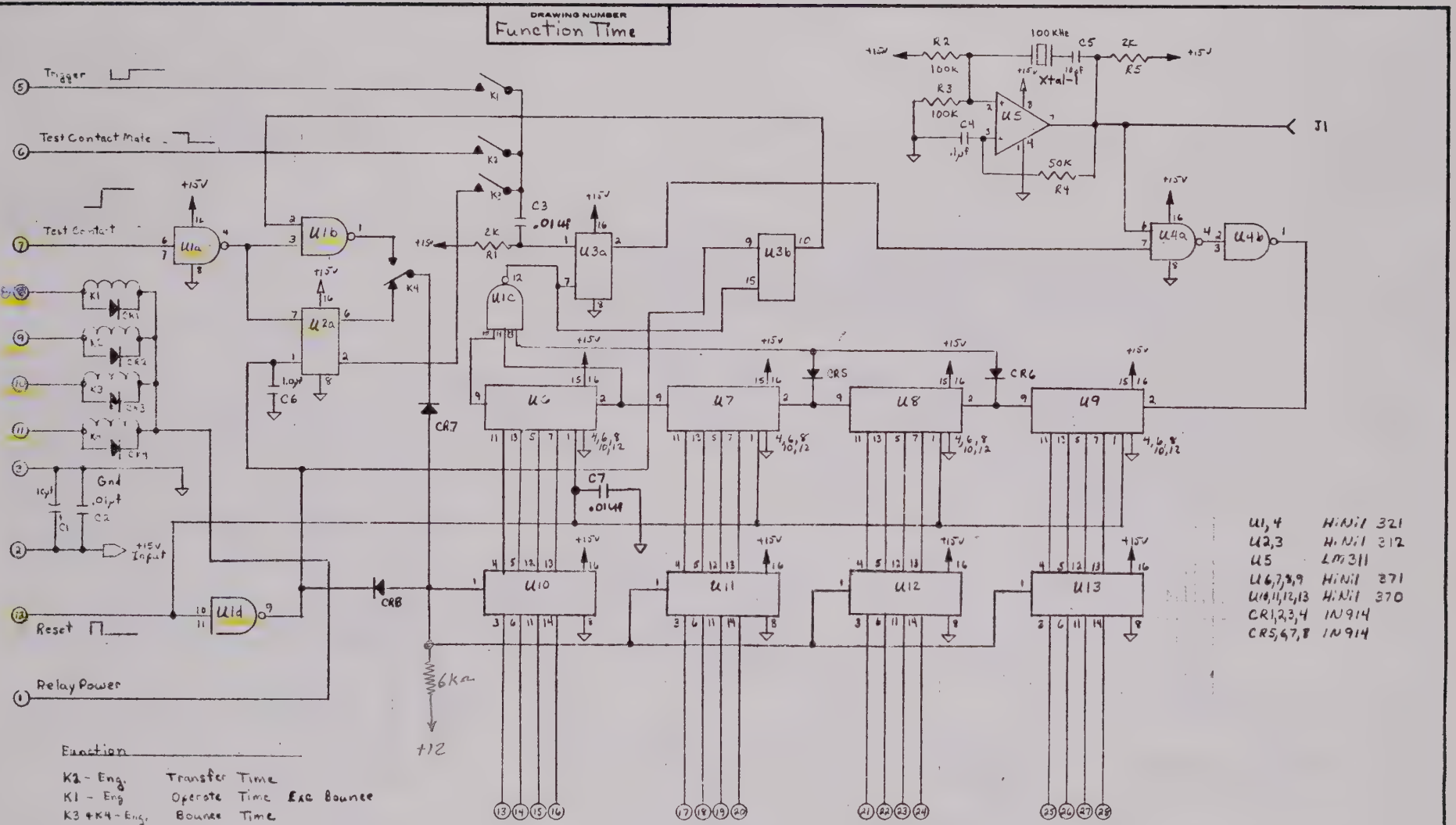
D$1,2,3,H – 3015F-8M15 (16 PIN DIP) Readouts Inc.

D.P. is placed by using one of R29,30,31 or 32

SIZE	CODE IDENT NO.	DRAWING NUMBER	REV.
A	09026	E2026 Decoder/Display	Nc
SCALE NONE	1 Feb. 74 LLD	SHEET OF	

DRAWING NUMBER

Function Time



U1, 4	HiNil 321
U2, 3	HiNil 312
U5	LM311
U6, 7, 8, 9	HiNil 371
U10, 11, 12, 13	HiNil 370
CR1, 2, 3, 4	IN914
CR5, 6, 7, 8	IN914

Function

K2 - Eng.	Transfer Time	
K1 - Eng	Operate Time	Exc Bounce
K3 + K4 - Eng.	Bounce Time	
K1 & K4 - Eng	Operate Time	Inc. Bounce

SIZE	CODE IDENT NO.	DRAWING NUMBER	REV
B	09026	E2023	B

SCALE			SHEET
None	1-31-74		OF
	7-7-74	LLD	

OK JB 8/31/81

DRAWING NUMBER

Control Card

U1,2,5,12,13 – HINIL 321
U3,4 – HINIL 323
U6,8,9,11,14 – LM555
U7,10 – HINIL 312
Q1,2 – MPS-A14
CR1-8 – IN4148

PULL-IN SELECT (5)
UPPER LIMIT (6)
NO1 (7)
NO2 (8)
NO3 (9)
NCH (10)
NC1 (11)
Relay Power (1)
NC2 (12)
FC2 DISABLE (13)
NO3 (14)
FC3 DISABLE (15)
NCH (16)
FCH DISABLE (17)
BACK-OUT SELECT (18)
LOWER LIMIT (19)

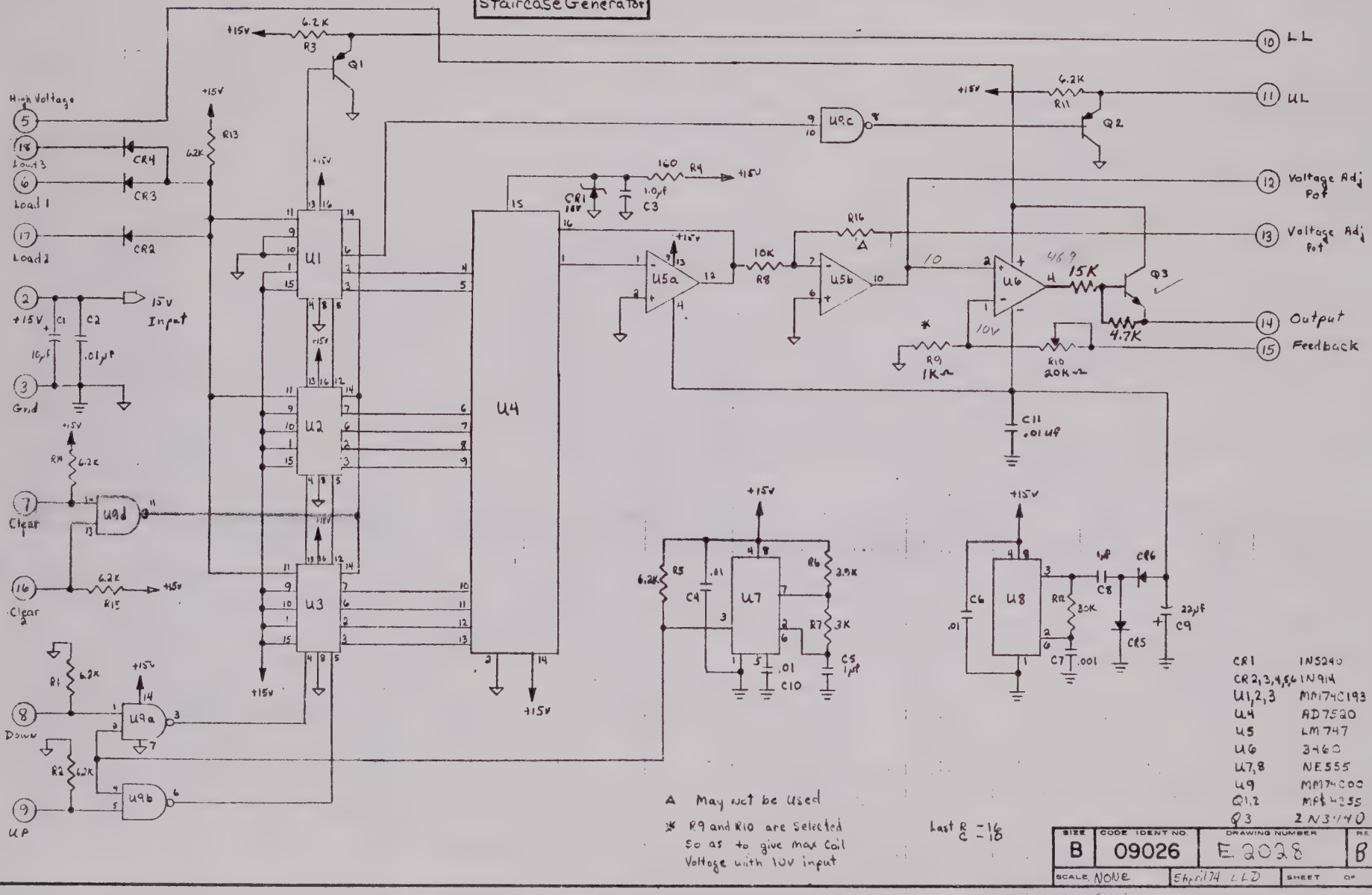
UP (20)
CLEAR (21)
DOWN (23)
LOAD (24)
DWELL HOLD (25)

SIZE	CODE IDENT NO	DRAWING NUMBER	REV
B	09026	E2024	E

SCALE NONE | 1-25-74 LLD | SHEET OF

E 5-3-74 LLD
D 2-28-74 LLD

DRAWING NUMBER
Staircase Generator



CR1	IN5240
CR2,3,4,5,6	IN914
U1,2,3	MM74C193
U4	AD7520
U5	LM747
U6	3460
U7,8	NE555
U9	MM74C00
Q1,2	MPF4355
Q3	2N3440

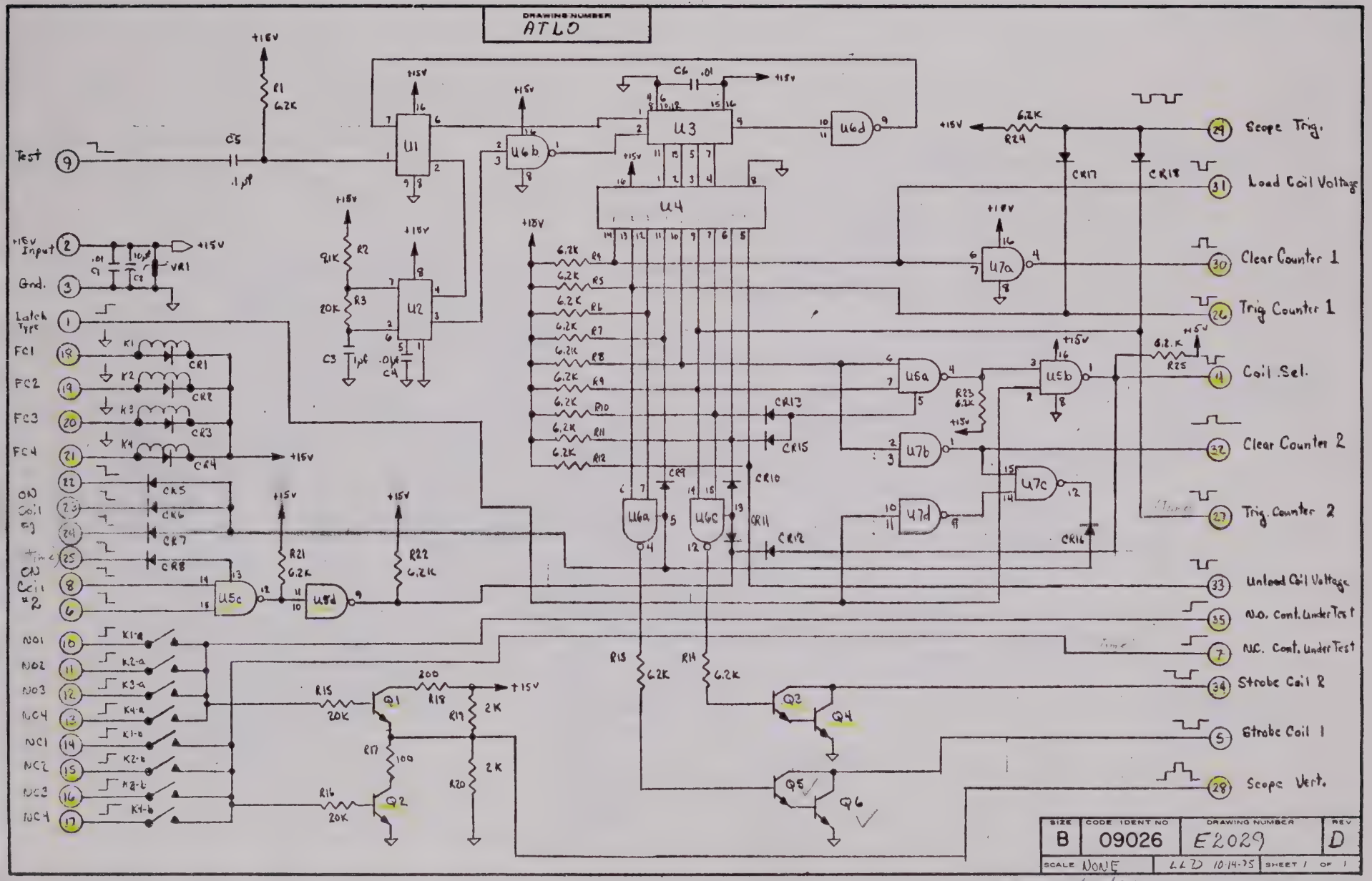
A May not be used

* R9 and R10 are selected so as to give max Coil Voltage with 10V input

Last R = 16
C = 18

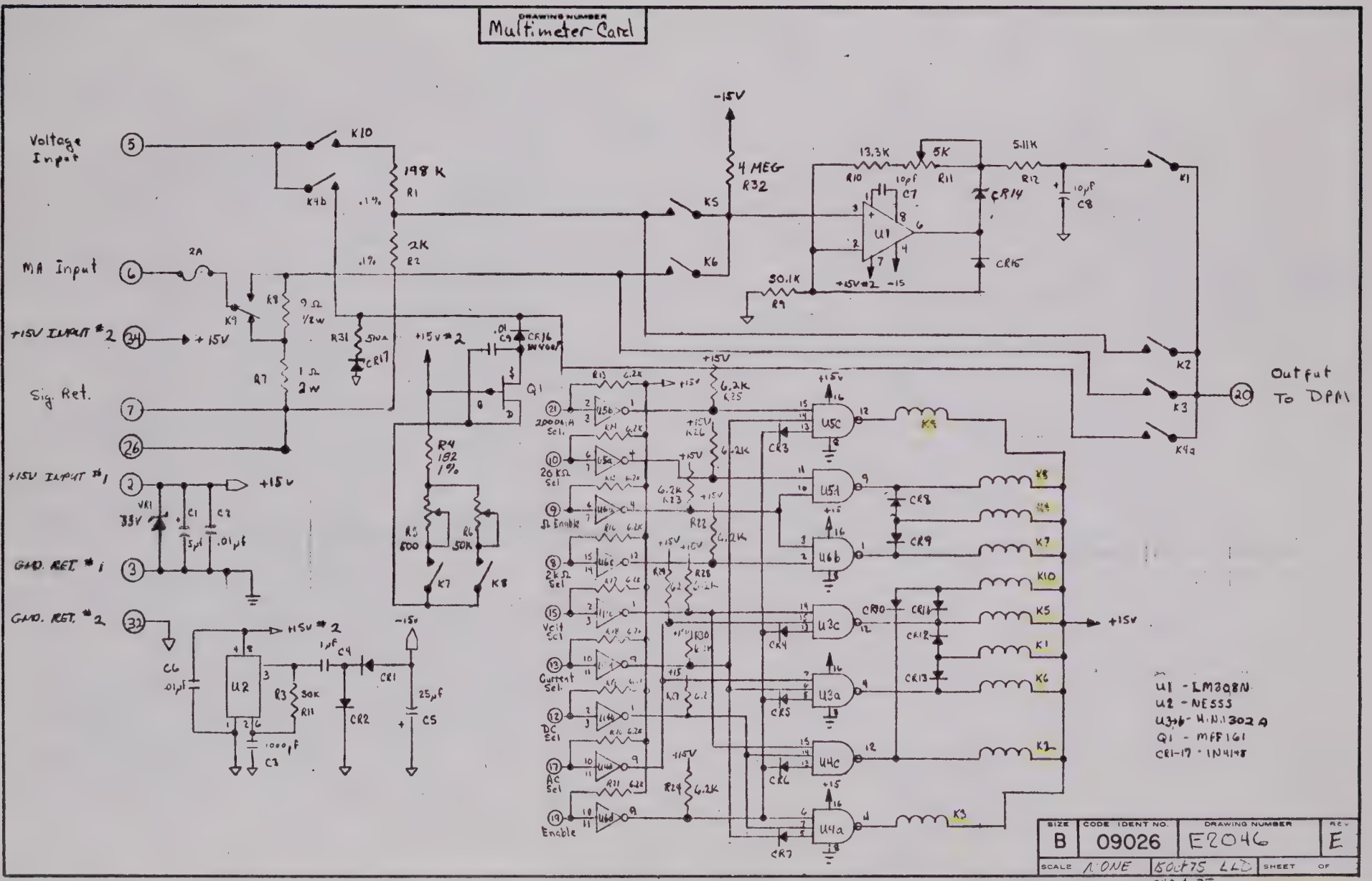
SIZE	CODE IDENT NO.	DRAWING NUMBER	REV
B	09026	E 2028	B
SCALE NONE	5 April 74 LLD	SHEET OF	

2K, +B 7/30/81


DRAWING NUMBER
ATLO
Test
Latch Type
+15V Input
Gnd.
FC1
FC2
FC3
FC4
ON Coil #1
ON Coil #2
NO1
NO2
NO3
NO4
NC1
NC2
NC3
NC4
Scope Trig.
Load Coil Voltage
Clear Counter 1
Trig Counter 1
Coil Sel.
Clear Counter 2
Trig. Counter 2
Unload Coil Voltage
N.O. Cont. Under Test
N.C. Cont. Under Test
Strobe Coil 2
Strobe Coil 1
Scope Vert.
SIZE B
CODE IDENT NO 09026
DRAWING NUMBER E2029
REV D
SCALE NONE
LLD 10-14-75
SHEET 1 OF 1

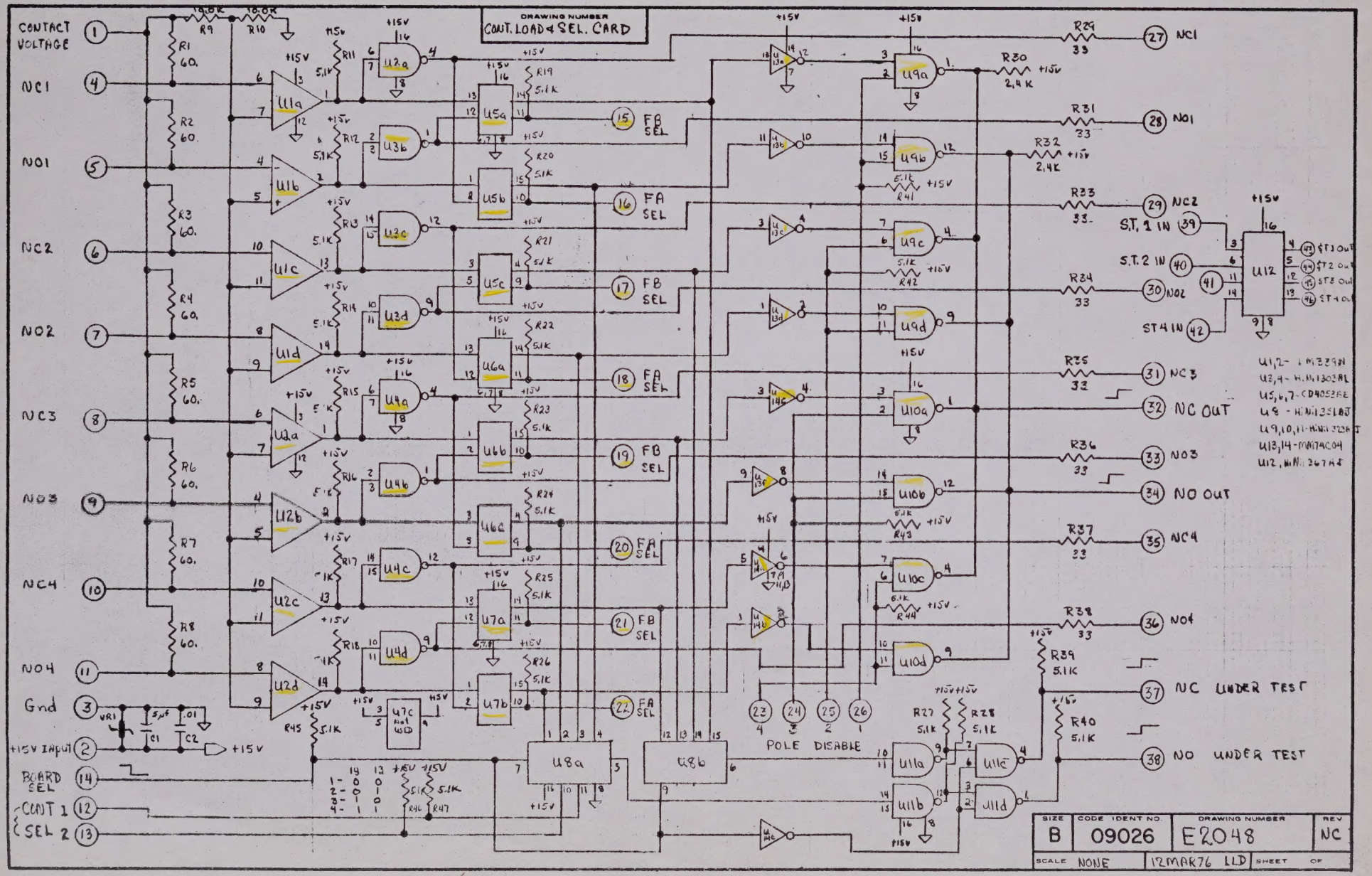
DRAWING NUMBER

Multimeter Card



SIZE	CODE IDENT NO.	DRAWING NUMBER	REV
B	09026	E2046	E
SCALE 1:ONE	5Oct75 LLD	SHEET	OF

+B/7/3/E/ 24Oct 75


DRAWING NUMBER
CONT. LOAD & SEL. CARD
CONTACT VOLTAGE
NC1
NO1
NC2
NO2
NC3
NO3
NC4
NO4
Gnd
+15V INPUT
BOARD SEL
CONT 1
SEL 2
FB SEL
FA SEL
POLE DISABLE
NC1
NO1
NC2
NO2
NC3
NC OUT
NO3
NO OUT
NC4
NO4
NC UNDER TEST
NO UNDER TEST
ST. 1 IN
ST. 2 IN
ST 4 IN
SIZE B
CODE IDENT NO. 09026
DRAWING NUMBER E2048
REV NC
SCALE NONE
12MAR76 LLD
SHEET OF